AUTO – TRACKING ANTENNA DESIGN

UAS in the NAS Project
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Abstract

Antennas are used to send and receive information wirelessly. Omnidirectional antennas don't need to be pointed at each other, but they don't have as long a range as directional antennas. Directional antennas also enable higher data rates, but using them for UAV's requires a tracking mount to keep the antenna pointed at the target. One problem with using them with UAVs is UAV's typically have multiple antennas that send and receive different types of information, and smaller tracking antennas typically only have one antenna mounted per tracking station, or they require cables running to the antennas that prevent continuous rotation.

This problem can be solved by creating a rotating antenna mount on which multiple antennas are fixed, and which maintains all antennas pointed at the target. The project designed and built a pedestal with an antenna mount capable of continuous rotation in azimuth and 220 degrees in elevation, while supporting multiple antennas and enabling a continuous rotation. Pro Engineer, a 3-D CAD software, is used to create three-dimensional parts and an assembly to validate the design. A rod parallel to the y-axis allows multiple antennas to be attached, minimizing inertia while rotating the antennas in elevation.

Limitations of Existing Technology

Current commercial auto-tracking products are viable, but not ideal for use with UAV's. UAV's typically have multiple antennas at different frequencies. Many tracking antennas only support one antenna per unit. This would require multiple tracking stations for each UAV. Smaller systems do not support true continuous tracking. These tracking systems do not contain slip rings or RF rotary joints which enable continuous rotation. During the cable-unwind action, there is a loss of connection to the aircraft. Most tracking antenna systems are also heavy due to large motors, which this design mitigates with design features that minimize the moment of inertia about azimuth and elevation.

Top Design Requirements

1. rotate in the azimuth plane and elevation axes simultaneously
2. hold 4x18" directional antennas of different types
3. small, lightweight, low power (< 50 pounds upper assembly, powered via conventional 120 VAC, 30 amp supply)

Design Process

The initial design was created using Pro Engineer which is a 3-D Computer Aided Design (CAD) software. This initial design included parts that would need to be machined, parts to be bought, an assembly to verify the design, and all related technical drawings.

The next step was to work with the Experimental Fabrication Shop to revise the assembly and drawings so they could create the system as intended. This helped to ensure the assembly would be made correctly with few changes to the drawings during the machining process. By having clear drawings, the machine shop could spend less time creating the parts which means less money to manufacture.

Table 1

Dist. from center (in)	Weight (lbs.)
10	93.75
12	65.10417
14	47.83163
16	36.62109
18	28.93519
20	23.4375
22	19.36983
24	16.27604
26	13.86834
28	11.95791
30	10.41667

The rotary actuator can achieve maximum specified acceleration with 29lbs of antenna per side with a center of gravity for the side located 18 inches from the center (table 1). Existing antenna mounts are typically plates mounted on an arm which is pivoted about a central axis, with dead mass used as counterweight, limiting the antenna size. Each of the antennas on the tube will be counterbalanced with its corresponding receiver or transmitter to allow for smaller motors and larger antennas.

The whole antenna system will be shielded from weather and the sun by an RF-transparent shroud. The shroud will keep sand from getting between the gears and inside the motors, which will prolong the life of the system.

Results

The results of this project is an antenna system capable of tracking an aircraft with 4 antennas moving at 200 knots 500 feet from the antenna. Figure 1 shows the finalized CAD model. Custom parts will be made out of 2024 Aluminum by the Experimental Fabrication Facility. Once the prototype is tested, modifications can be made to the product and the design can be finalized. As stated earlier, the designed antenna system will be able to rotate about 29 lbs. of counterbalanced antennas per side (58 lbs. total) at its specified rotational acceleration.

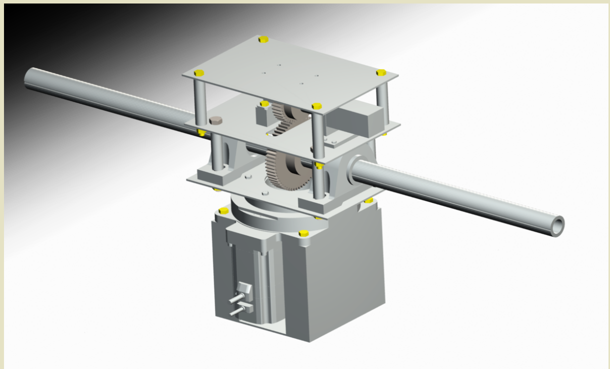

Figure 1: Shows the CAD model of the antenna system. The antennas will be arranged in such a way that the center of mass is at the center of the tube. Each antenna will be counterbalanced.

Conclusion

In conclusion, the auto-tracking antenna is designed for use in the UAS in the NAS project to track aircraft with multiple antennas using different frequencies as they are flying. The wires to transmit power and data can connect through a fiber optic rotary joint which will allow for continuous rotation, slip rings for data and video that is rated properly, or the cables can be run straight through to save money if continuous rotation is not needed. The pedestal assembly is driven by PPM control signals. This tracking antenna is designed to be compatible with the requirements of X-56A, DROID, and Towed Glider, so it can support their needs as well.